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Cluster Analysis of Customer Churn in Telecom Industry

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Abstract**—**The research examines the factors that affect customer churn (CC) in the Jordanian telecom industry. A total of 700 surveys were distributed. Cluster analysis revealed three main clusters. Results showed that CC and customer satisfaction (CS) were the key determinants in forming the three clusters. In two clusters, the center values of CC were high, indicating that the customers were loyal and SC was expensive and time- and energy-consuming. Still, the mobile service provider (MSP) should enhance its communication (COM), and value added services (VASs), as well as customer complaint management systems (CCMS). Finally, for the third cluster the center of the CC indicates a poor level of loyalty, which facilitates customers churn to another MSP. The results of this study provide valuable feedback for MSP decision makers regarding approaches to improving their performance and reducing CC.

Keyword**—**Cluster analysis, telecom industry, switching cost, customer churn.

I. Introduction

THE mobile sector is considered the fastest growing sector of the telecom industry. Globally, the high CC is a real problem that faces this industry. Therefore, companies shall regularly assess their performance [1]-[5]. Several studies have, therefore, been conducted to identify factors that influence CC [6], [7]. These factors are:

a. *CC* is considered as serious problem for MSPs that may lead to considerable profit losses. Customer loyalty is a strategy that enables an MSP to maximize their profits. Customer loyalty is highly correlated with CC [8], [9].
b. *Switching cost* (SC) includes the costs of informing others of the change, acquiring a new line, breaking the relationship with the MSP, and learning any new procedures in dealing with the new MSP [10]. Changing a mobile number is the main concern for customers, because the cost of a new line and breaking the relationship with the MSP is extremely cheap. Studies have shown a negative relationship between SC and CC [11], [12].
c. *CS* is considered the customer's evaluation of current MSP performance. A negative relationship was assumed between CS and CC [13].
d. *Trust (TR)* is defined as the level of reliability guaranteed by one party to another within a given exchange relationship [14]. TR occurs when a customer believes that the actions of an MSP will result in positive outcomes for them. Both customers and MSPs benefit from exchanging TR.
e. *COM* is the exchange of information over significant distances by electronic means [15]. COM includes network coverage and signal strength, which is related to voice clarity and network coverage are the main decision factors when choosing an MSP. It is common for COM to negatively influence CC.
f. *VASs* are defined as all services beyond standard voice calls; they can be used with available services at little or no cost, thus promoting the primary business of the MSP [16]. In the mobile sector, VASs include short message services (SMSs), multimedia message services (MMSs), ring tones, and web browsing. The purpose of a VAS is to improve the quality of services and add value to the primary service. Accordingly, VASs negatively influence CC.
g. *Customer expectations* (*CEs*) refer to the total perceived benefits that a customer expects from MSP services. An MSP has to recognize customer needs by accepting customer opinions into the offer design process, thus fulfilling CEs and achieving high CS during the customer service experience. A positive relationship is assumed between CEs and CS [17].
h. *CCMS* includes all of the assistance that an MSP offers to customers directly or indirectly prior to, during, and after purchases to provide a positive customer experience. The system comprises a call center, website, customer care, retail stores, and social media. A CCMS can produce customer behaviors that indicate potential CC. Thus, a positive relationship was hypothesized between CCMSs and CS [18].
i. *Brand image* (*BI*) is a mental setup developed in the customer's mind based on a few selected impressions from the particular services of an MSP [19]. A positive BI facilitates satisfying CEs and presenting more benefits to customers, thereby leading to enhanced CS and TR. Consequently, BI is positively and directly related to CS and TR.
j. *Price perception* (*PP*) includes the price of SIM cards, refill scratch cards, call rates, SMS charges, the Internet bundle charges, and the price of phones. Customers are willing to pay more if they really trust the MSP and are satisfied with the service [20]. An MSP with lower prices has a strong tendency to attract a substantial customer base, leading to an increased market share and improved financial performance. Price is correlated with TR and CS. In this research, cluster analysis will be conducted to

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segment customers of three main MSPs; MSPA, MSPb, and MSPc, into groups according to common interests and behavior.

II. Data Collection

Surveys were used for collecting data from MSP customers in Jordan. The structure of the survey comprised two sections. The first section collected the demographic information (age, gender, education, area of residence, MSP, MSP services, offer payment type, contract age (tenure), second line, data usage on mobile, average gigabyte (GB) consumption, average consumption in JOD, talking time on-net (within the same MSP), talking time off-net (outside the MSP), number of relatives within the same MSP). The second section presented measured items rated on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The measured items were SC, CS, TR, COM, VASs, CEs, CCMSs, BI, and PP. A pilot study was conducted to observe whether any of the statements were difficult for subjects to understand and to check for the appropriateness of the items used in the survey. The survey was reviewed by experts from academic institutes, in addition to market research experts from the telecom industry in Jordan. A total of 700 surveys were distributed in person and online (e-mail, Facebook, Twitter, LinkedIn), while 601 surveys were collected, giving a response rate of 86.8%.

III. Cluster Analysis

A. Demographic Analysis

The analytic results of the demographic parameters showed that most of the respondents (57%) were females. The highest percentage (42%) of respondents was between 24 years and 30 years old, whereas the smallest percentage (5%) was more than 40 years old. Among all of the respondents, approximately 61% had attained a bachelor's degree, and approximately 63% lived in Amman. Among the three MSPs considered, most of the respondents used the MSPA mobile company (45%), followed by MSPB (42%) and MSPC (13%). In addition, approximately 68% of the respondents used prepaid lines, whereas postpaid customers comprised approximately 32% of the respondents. Approximately 96% of the respondents used data on their mobiles, with 26% spending 5–7JOD, followed by 21% spending 3-5JOD, 7–10JOD, or >10 JOD and 11% spending 0–3JOD. In addition, approximately 57% of the respondents had used their current line for more than four years. Approximately 26% talked less than 100 minutes per month within their MSP, followed by 21% talking 100–300 minutes. By contrast, approximately 47% of respondents talked less than 100 minutes per month with other MSPs. Finally, approximately 78% of respondents knew more than four people who used the same MSP.

B. Cluster Analysis

The hierarchical method was used to determine the number of clusters, as the first step in performing nonhierarchical clustering. Squared Euclidean distance (SED) measures dissimilarity between cases. The Ward's method was selected as the cluster algorithm to minimize the within-cluster differences and to avoid the problem of observation chaining that is found in the single linkage method. Ward's method is an agglomerative hierarchical technique; therefore, each of the 601 cases was considered a separate cluster, meaning that 601 clusters should be combined into one cluster. Ward's method uses the squared Euclidean distance matrix for combining the cases, stage-by-stage, into smaller numbers of clusters, working from the minimal to the maximal value of distance found within the clusters while calculating the agglomeration coefficient for each stage. Table I displays part of the calculated agglomerative coefficient and has columns denoting the stages, combined clusters, coefficients, when the clusters first appear, and when the clusters appear subsequently. The agglomerative coefficient from Stage 1 to Stage 53 was zero, which represented the minimal value in the SED matrix. In Ward's method, the agglomeration coefficient is particularly useful as a stopping rule that evaluates changes in the coefficient at each stage of the hierarchical process. Low coefficients indicate that fairly homogenous clusters are being merged; joining two extremely different clusters results in a high coefficient or a high percentage change in the coefficient. After coefficients are calculated, the number of clusters is determined by drawing the agglomeration schedule coefficients. Fig. 1 shows the agglomeration schedule coefficients.

The "elbow" rule was used to determine the preferred number of clusters; specifically, as the agglomeration of values was plotted in the coefficient diagram, the number of clusters was chosen at the stage that showed the maximal change in slope. As shown in Fig. 1, the maximal change in slope occurred at stage 598. At this stage, the number of clusters was determined as: Number of clusters= Total number of respondents -Stage number = 601-598 = 3 clusters.

Analysis for the three clusters was performed using the nonhierarchical method (k-means method). Nonhierarchical clustering is used to adjust results according to hierarchical procedures. The number of cases in each cluster was determined. Cluster 2 was determined to contain the highest number of respondents (321), whereas Cluster 3 exhibited the lowest number of respondents (111). Cluster 1 had 169 respondents. Table II displays the cluster centers of the 10 studied model factors.

The distances between the cluster centers were obtained (Table III). The smallest distance between Clusters 1 and 2 is 2.111.

IV. Results

Analyses of the six demographic factors—age, gender, MSP, education, area of residence, and tenure—of each cluster were conducted and showed significant differences among the clusters for each factor (Fig. 2). The cluster analysis of the 321 respondents in Cluster 2 showed that 215

lived in Amman and that 214 had a bachelor's degree. There were 199 female respondents. Among the respondents in this cluster, 143 respondents were between 24 years and 30 years old, and 148 had more than four years of tenure; 137 respondents used the MSP_B, whereas 144 used the MSP_A. As shown in Table III, the center of the CC cluster for Cluster 2 exhibited a value of 3.90. Factors CS (3.75), SC (3.70), CEs (3.62), BI (3.85), TR (3.59), and PP (3.46) showed good center values. Factors COM (2.95), VASs (2.39), and CCMSs (2.96) exhibited poor center values. The center value of CC was high, indicating that the customers were not willing to leave this MSP because they felt that the SC was expensive and time- and energy-consuming and that losing their existing phone number was burdensome. More importantly, CEs were met, which led to CS. The MSP possessed good BI and TR levels and pricing flexibility. Nevertheless, the MSP should improve its COM characteristics, enhance the quality of the VASs, and establish an effective CCMS.

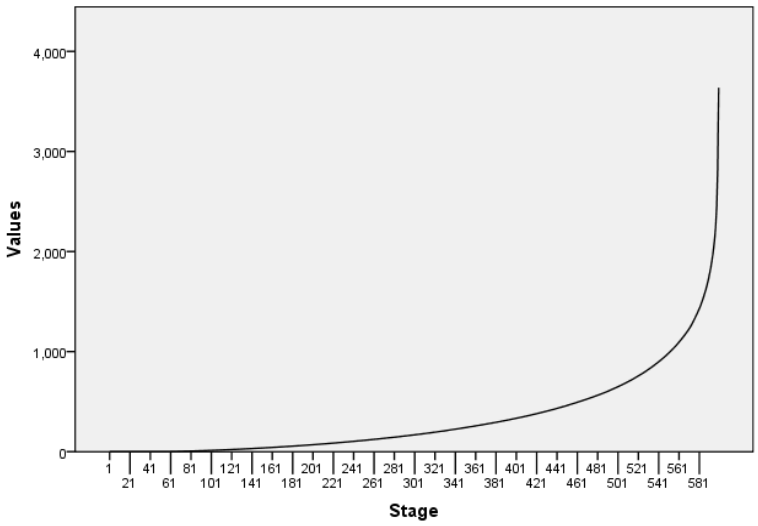

Fig. 1 Agglomeration schedule coefficient

TABLE I
SAMPLE OF THE AGGLOMERATION SCHEDULE

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	443	444	0	0	0	426
2	427	428	0	0	0	367
3	423	424	0	0	0	4
4	403	423	0	0	3	6
5	421	422	0	0	0	6
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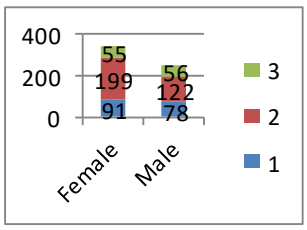
598	4	5	2435	596	586	599
599	3	4	2840	595	598	600
600	1	3	3637	597	599	0

TABLE II
CLUSTER CENTERS

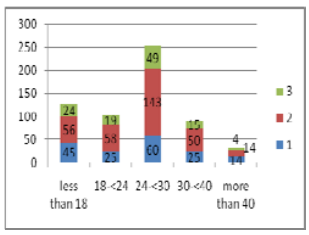
Item	Cluster		
	1	2	3
CC	4.64	3.90	2.65
CS	4.59	3.75	2.60
TR	4.41	3.59	2.71
SC	3.99	3.70	3.44
COM	3.49	2.95	2.27
VAS	2.83	2.39	2.29
CE	4.41	3.62	2.83
BI	4.57	3.85	3.16
PP	4.29	3.46	2.80
CCMS	3.36	2.96	2.68

TABLE III
DISTANCE BETWEEN THE CLUSTER CENTERS

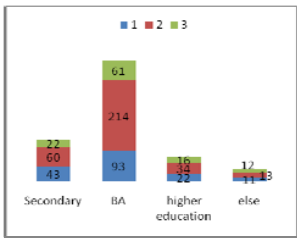
CLUSTER NUMBER	1	2	3
1	-	2.111	4.468
2	2.111	-	2.407
3	4.468	2.407	-



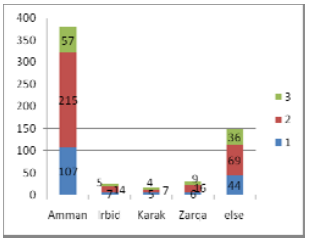
(a) Gender



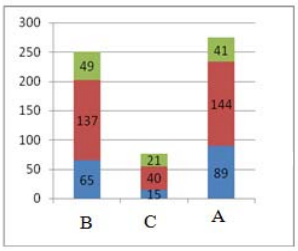
(b) Age



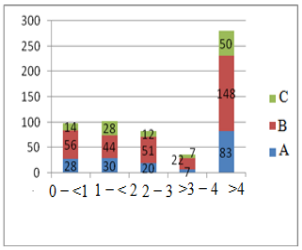
(c) Education



(d) Area of residence



(e) MSP



(f) Tenure

Fig. 2 Demographic histogram clusters

TABLE IV
ANOVA RESULTS

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
CC	131.55	2	0.25	598	517.08	0.00
CS	132.86	2	0.23	598	568.93	0.00
TR	97.69	2	0.35	598	278.91	0.00
SC	10.25	2	0.58	598	17.57	0.00
COM	49.41	2	0.40	598	124.62	0.00
VAS	13.48	2	0.47	598	28.61	0.00
CE	85.72	2	0.27	598	317.09	0.00
BI	68.86	2	0.29	598	234.86	0.00
PP	78.27	2	0.34	598	233.58	0.00
CCMS	16.29	2	0.61	598	26.90	0.00

The cluster analysis of the 169 respondents in Cluster 1 showed that 107 lived in Amman and that 93 had a bachelor's degree. There were 91 female respondents. Among the respondents in this cluster, 60 respondents were between 24 years and 30 years old, and 83 had more than four years of tenure; 65 respondents used the Company B, whereas 89 used MSP_A. As shown in Table III, the center of the CC cluster for Cluster 1 exhibited a value of 4.64. Factors CS (4.59), CEs (4.41), BI (4.57), TR (4.41), and PP (4.29) indicated excellent center values; SC (3.99) showed a very good center value; COM (3.36) and CCMS (3.36) showed good center values; and VASs (2.83) exhibited a poor center value. The customers in this cluster showed a greater loyalty to their MSPs than those in Cluster 2 because of excellent CS, effectively having their expectations satisfied, which led to a high level of CS and established a high TR level, reputable BI, and cost-effective pricing. Moreover, the respondents felt that switching to another MSP was costly and that the CCMS was fairly effective. Finally, the MSP should direct more attention to enhancing VASs, which showed the smallest center value. Finally, the cluster analysis of the 111 respondents in Cluster 3 showed that 57 lived in Amman and that 61 had a bachelor's degree. There were 56 male respondents. Among the respondents in this cluster, 49 respondents were between 24 years and 30 years old, and 50 had more than four years of tenure; 49 respondents used MSP_C, whereas 41 used MSP_A. Further, the center of the CC cluster for Cluster 3 was a value of 2.65, which indicated a poor level of loyalty and hence a high churn rate. In this cluster, SC (3.44) and BI (3.16) exhibited good center values, which indicated that the BI of the MSP was fair and that the SC was not costly, thus facilitating customers changing to another MSP. The other factors showed weak levels.

Finally, the value of an item's mean square represents the effect of the item on the forming of the clusters. Table IV shows the analysis of variance (ANOVA). It was found that the factors CC and CS were the key determinants in establishing the three clusters.

V. Conclusion

Cluster analysis was successfully conducted to investigate the effects of SC, CS, TR, COM, VASs, CEs, CCMS, BI, and PP with their effects on CC in the telecom industry. First, the hierarchical method was used to determine the number of clusters. The Ward's method was then selected as the cluster algorithm to minimize the within-cluster differences. Three clusters were formed and then discussed. For the first cluster analysis of the 169 respondents, the center of the CC cluster is 4.64. The center of factors revealed that COM and CCMS showed good center values, whereas VASs exhibited a poor center value. The cluster analysis of the 321 respondents in the second cluster showed the center of CC is 3.90, with poor center values of COM, VASs, and CCMSs. In both clusters, the center values of CC were high. Nevertheless, the MSP should improve its COM characteristics, enhance the quality of the VASs, and establish an effective CCMS. Finally, for the third cluster of the 111 respondents, the center of the CC was very poor; high churn rate because the SC was not inexpensive and thereby customers often change to another MSP.

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